Population status and habitat ecology of Bristled Grassbird *Chaetornis striata* in Chitwan National Park, central Nepal

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A study to determine the population status and assess the habitat ecology of the Bristled Grassbird *Chaetornis striata* was carried out in Chitwan National Park, Nepal. Using a call playback method to detect Bristled Grassbirds, the total population was estimated at 4,570±1,270 individuals. Bristled Grassbirds were five times more likely to occur in grassland dominated by *Saccharum spontaneum* than in grassland where other grasses predominated, and their presence was negatively correlated with tree density. Grassland lightly grazed by wild herbivores was found to be three times more likely to hold Bristled Grassbirds than similar grasslands where grazing was assessed as medium, whilst more heavily grazed grasslands used by domestic livestock were avoided. The preference for grasslands at an early successional stage suggests that the loss of such grasslands to scrub could be a major threat to the Bristled Grassbird, which occurs sparingly in lowland grasslands in Nepal below 300 m.

INTRODUCTION

The Bristled Grassbird *Chaetornis striata* is endemic to South Asia, occurring in Bangladesh, India, Nepal and Pakistan (Ali & Ripley 1987, Grimmett *et al.* 1998). It has a small and declining population, and is classified as nationally threatened in Nepal and by IUCN as globally Vulnerable (Inskipp 1996, BCN & DNPWC 2011, BirdLife International 2015). It was formerly included with the Old World warblers Sylviidae but its true affinity has not yet been established. External morphology suggests it might belong in the newly established grass warbler family Megaluridae (BirdLife International 2015) and it is now placed in the monotypic genus *Chaetornis*.

Very little is known about the Bristled Grassbird in Nepal, where the species was known from four protected areas up to 2001 (BirdLife International 2001), namely Royal Sukla Phanta Wildlife Reserve, Royal Chitwan National Park, Lumbini Sanctuary and Kosi Tappu Wildlife Reserve, and has been recorded at a few other sites since. Bristled Grassbirds are reported to prefer densely vegetated, medium to tall grasslands, mostly on dry soils but also in moist areas (although it is absent from wet *Phragmites* grasslands) and with tall, unburnt reeds or scattered bushes/trees which are used as vantage points. The height of unburnt grass at all occupied sites was 2.5–3 m, although at some sites there were also grasses burnt in previous fires present which were up to 1.5 m tall (Baral 1997, 2000b).

The major threat to this grassland specialist is thought to be the vulnerability of its small, rapidly declining population to loss and degradation of its grassland habitat, primarily through drainage and conversion to agriculture (BirdLife International 2015). However, invasive plant species, including *Mikania micrantha*, *Lantana camara* and *Eupatorium adenophorum*, are expanding into Nepalese grasslands, with *Mikania* being the most serious invader in Chitwan NP (Sapkota 2007). These invasive species generally grow and spread rapidly, preventing light penetration to ground level. If not controlled they replace the grassland, resulting in the loss of Bristled Grassbird habitat. Many grasslands of conservation value are included in protected areas but continue to suffer degradation through mismanagement (Baral 1998). The protected area priority of managing grasslands for large herbivorous mammals has resulted in the creation of short, young vegetative grass at the expense of taller, mature grassland (Baral 2000a). More information is needed to reconcile the conflicting habitat requirements of the wide range of threatened species occurring in Nepal's national parks.

This study focused specifically on the population status and habitat ecology of the Bristled Grassbird in Nepal during the breeding season and assessed threats to its habitat.

METHODS

Study area

Chitwan National Park, 932 km^2 in area, is located in the lowland Dun Valley at 27.250–27.583°N and 83.750–84.967°E (Figure 1). The park is a complex of ecosystems comprising Churia hills, ox-bow lakes and floodplains along the Rapti, Reu and Narayani rivers. It was recognised as a World Heritage Site in 1984 for the richness of its biodiversity, scenic landscape and the unique Tharu Cultural Heritage (DNPWC 2013). It is home to many threatened mammals, birds and reptiles. In total 540 bird species have been recorded from the park (Baral & Upadhyay 1998).

Avifaunal surveys

The study was carried out over six weeks between 31 March and 15 May 2010. Four grassland areas were selected: Khagendramalli, Sahuraha-Padampur and Bhimle-Meghauli on the Rapti River floodplain, and Bankata-Madi on the Reu River floodplain. Sample plots 75 m in radius were established at 200 m intervals along transect lines laid perpendicular to the rivers at intervals of 250 m. The total of 105 sample plots comprised 18 plots in Khagendramalli, 29 in Sahuraha-Padampur, 30 in Bhimle-Meghauli and 28 in Bankata-Madi. At each plot, Bristled Grassbirds were counted and habitat condition was assessed. Playback was used to maximise the probability of detecting birds (Gregory *et al.* 2002). Calls of Bristled Grassbird were played from the centre of each plot three times, followed by five minutes listening for responses. Each survey was carried out between 07h00 and 10h00 in calm conditions. No Bristled Grassbirds were detected during the first surveys between 31 March and 16 April. A partial second round of surveys between 1 and 15 May involved 62 plots in the three Rapti floodplain sites and six plots in the Reu floodplain. Plain Prinia *Prinia inornata*, Grey-crowned Prinia *P. cinereocapilla* and Slender-billed Babbler *Turdoides longirostris* were surveyed at the same time using the same methodology.

Habitat sampling

The structure of the grassland habitat was measured within each 75 m radius plot (Bristled Grassbirds were assumed to be detectable up to 75 m from the observation point). The densities of the dominant

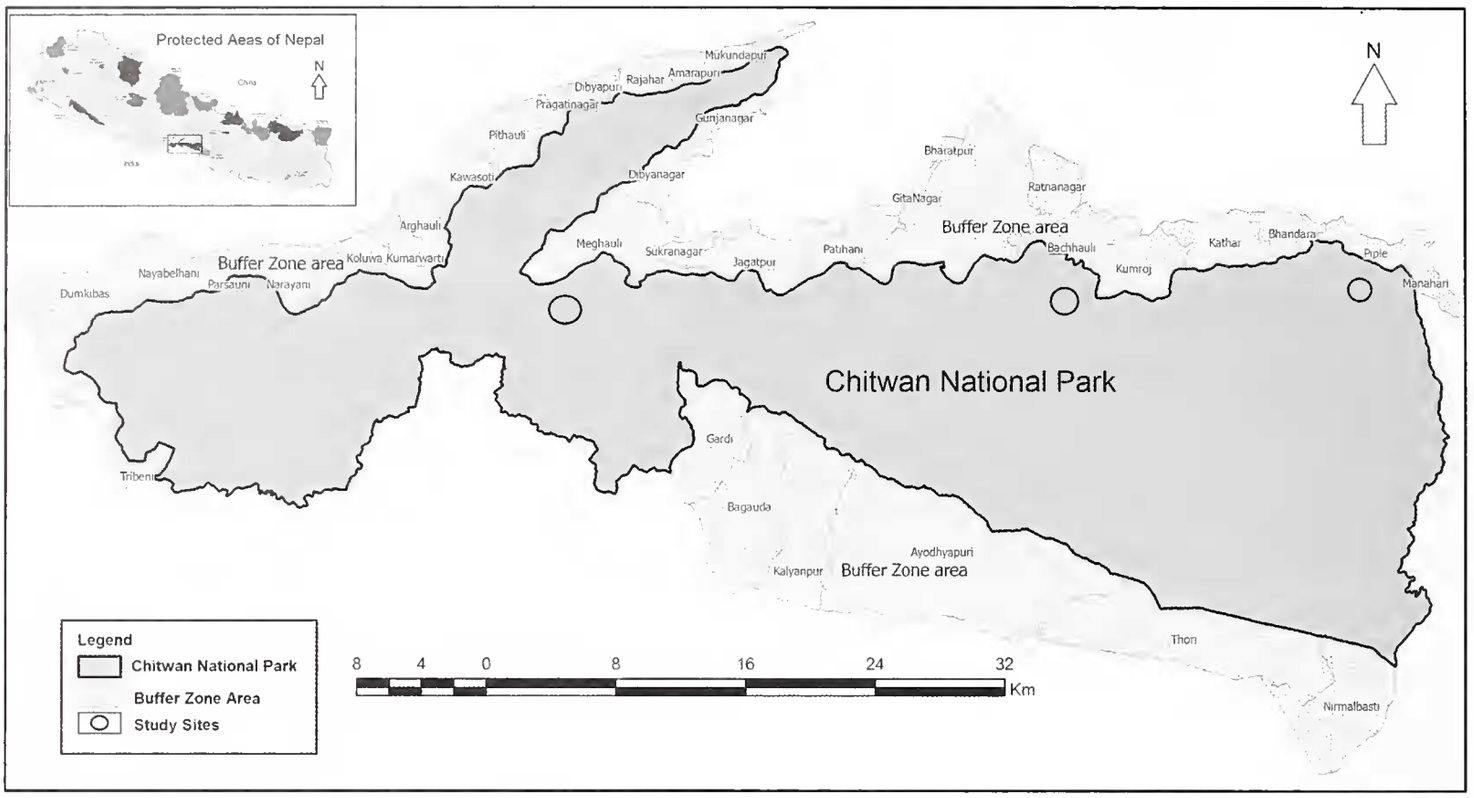

Figure 1. Study area: Nepal and Chitwan National Park.

tree, shrub and grass species were measured together with overall vegetation cover. Trees and shrubs were counted in 50 m and 25 m radius plots respectively, grass shoots were counted in 1×1 m quadrats and their densities were calculated separately. Vegetation cover was recorded in percentage bands (no cover 0%, very sparse < 25%, medium 25–75%, high > 75%). Grazing intensity was measured on an ordinal scale: heavy, medium or light. Grazing by wild herbivores was considered to be light, whereas grazing by domestic livestock was graded medium to heavy. The presence of potential habitat threats, such as forest roads/trails, forest fires and colonisation by invasive plant species, was also recorded. All the aforementioned parameters were also measured in plots where no grassbirds were recorded.

Data analysis

Using methods detailed by Rodgers (1991), Bristled Grassbird numbers were analysed to provide mean population sizes and confidence intervals for each surveyed grassland plot, using the plot-level densities from the second round of survey visits. Based on the total area of suitable grassland habitat, a population estimate for the entire national park was made using mean plot-level density and pooling data from all the surveyed grasslands. Thapa (2011) classified the grassland of Chitwan NP into five grassland types: floodplain, short, tall swampy, tall and wooded. The perennial Kans grass *Saccharum spontaneum* alone or as the dominant species was found only in floodplain and tall grassland. For this study, suitable grassland for Bristled Grassbird was defined by the presence of *Saccharum spontaneum*, which was reported to occupy 84.64 km^2 of Chitwan NP (Thapa 2011).

The effect of habitat condition on Bristled Grassbird occurrence (probability of occurrence in a sample) was modelled using logistic regression. Six explanatory variables were tested (Table 1). The final multivariate model was built using a step-down approach, starting with the model incorporating all six variables and deleting the least significant variables, one at a time, until all the remaining variables were significant (Type III tests, $p < 0.05$).

Model fit was assessed by plotting observed values against predicted values of the probability of occurrence. The effect of each explanatory variable in the final model was examined separately, with the other explanatory variables fixed at their mean value (or weighted means of categorical variables). When examining continuous variables, observations were ranked by the continuous variable and divided into equal groups for which means (± standard errors) were plotted as the observed values.

Table 1. Explanatory variables used in logistic regression models with summary data (mean and range for continuous variables, frequency of occurrence for categorical variables).

Variable	Variable type	Description	Summary data
Tree density (TD)	Continuous	Number of trees within 50 m radius	9 (10–110)
Shrub density (SD)	Continuous	Number of shrubs within 50 m radius	6 (0–50)
Grass density (GD)	Continuous	Number of grass shoots per m^2	78 (0–90)
Vegetation cover (VC)	Categorical	Medium = 25–75%, dense > 75%	M = 21, D = 42
Grazing intensity (GI)	Categorical	Light, medium or heavy	L = 35, M = 28, H = 0
Dominant grass species (DS)	Categorical	DS = *Saccharum spontaneum* dominated, 0 = other species	DS = 49, 0 = 14

RESULTS

Bristled Grassbird population estimates

A total of 60 Bristled Grassbirds was observed in 34 of the 62 sample plots surveyed along the Rapti floodplain in the second round of visits. The estimated populations and 95% confidence intervals are presented in Table 2. The estimated population for the whole of the park, 4,570±1,270 individuals, was based on the observed mean density in *Saccharum spontaneum*-dominated grasslands,

Table 2. Estimated population sizes of Bristled Grassbird in Chitwan NP based on plot counts in three study grassland areas.

Study grassland	No. survey plots	Bird density km^{-2}±95%CI	Potential habitat (km^2)	Population estimate (individuals)
Sahuraha-Padampur	20	54±31	4.75	257±148
Bhimle-Meghauli	20	62±27	3.56	221±96
Khagendramalli	22	46±26	6.87	316±179
Total for Chitwan NP	62	54±15	84.64	4,570±1,270

including pure stands and associations with other species of grass such as *Narenga porphyrocoma*.

Plant species diversity

Table 3 lists the main tree, shrub and grass species recorded in survey plots occupied by Bristled Grassbirds. Only five tree species were recorded in occupied survey plots, whereas 25 tree species were recorded from unoccupied plots. Similarly, nine shrub species and 10 grass species were recorded in occupied plots, compared with 20 shrub species and 14 grass species in unoccupied plots.

Table 3. Tree, shrub and grass species recorded in plots occupied by Bristled Grassbirds in Chitwan NP.

Tree species	Shrub species	Grass species
Trewia nudifloro	*Clerodendron viscasum*	*Socchorum spontoneum*
Wendlandio corioceo	*Pogostemon bengolensis*	*Socchorum bengolensis*
Dalbergio sissoo	*Ziziphus mouritiono*	*Norengo porphyrocomo*
Acocio cotechu	*Colergoesio oppositifolio*	*Themedo orundinoceo*
Bambox ceibo	*Cupressus* sp. (n=2)	*Imperoto cylindrico*
	Calatrapis gigonteo	*Phragmites karka*
	Artemisia indico	*Agerotum conyzoide*
	Lantana camero	*Erionthus munja*
		Typho elephontina
		Eragrostis tenella

Vegetation density

Trees and shrubs were widely scattered in all grassland plots, but densities of both were markedly lower in plots occupied by Bristled Grassbirds. Average densities in occupied plots were 966 trees/km^2, 1,168 shrubs/km^2 and 85 grass stems/m^2, compared with 4,110 trees/km^2, 4,630 shrubs/km^2 and 72 grass stems/m^2 in unoccupied plots.

Logistic regression model

The final model containing three habitat variables (Table 4) was highly significant ($\chi^2 = 48.5$, $df = 6$, $p < 0.001$), and Nagelkerke's R^2 of 0.71 indicated a moderately strong relationship between prediction and grouping.

Table 4. Summary of the final logistic regression model describing the probability of occurrence of Bristled Grassbird in a sample plot.

Variables	Level	Parameter	Parameter SE	Wald test statistic	*P*-value for Wald test
Intercept		-0.62	1.27	0.23	
Tree density		-0.12	0.4	8.5	0.004
Dominant grass	*Saccharum spantaneum*	2.45	1.18	4.4	0.03
	Other species	0	–	–	–
Grazing intensity		1.80	0.86	4.2	0.04

Bristled Grassbirds were more likely to occur at lightly grazed sampling sites with low tree densities, dominated by *Saccharum spontaneum*. There was close agreement between the observed and predicted relationships for all three explanatory variables (Figures 2–4). Dominant grass species were strongly associated (multicollinearity) with lower tree densities at *Saccharum spontaneum*-dominated sample sites. This association was controlled for when calculating predicted values for the dominant grass species relationship (Figure 2), by using different mean tree densities for each type of grassland. Bristled Grassbirds were almost five times more likely to be found in *Saccharum spontaneum*-dominated grassland than in other types of grassland.

A density of less than 20 trees within a 50 m radius of the centre of each plot was strongly preferred, and the probability of occurrence increased rapidly as tree density approached zero (Figure 3). High levels of occupancy were recorded for *Saccharum spontaneum* grasslands with low tree densities (over two-thirds of sample sites). The model predicted that Bristled Grassbirds would be largely absent from grasslands with more than 40 trees within a 50 m radius circle.

Lightly grazed sites, typically grazed by wild herbivores (livestock grazing was only noted at four lightly grazed sample sites), were three times more likely to hold Bristled Grassbirds than more intensively grazed sites (Figure 4). Domestic livestock were mainly responsible for cases of medium grazing intensity. The effect of grazing intensity could, therefore, be due to differences in grazing patterns between wild herbivores and domestic livestock.

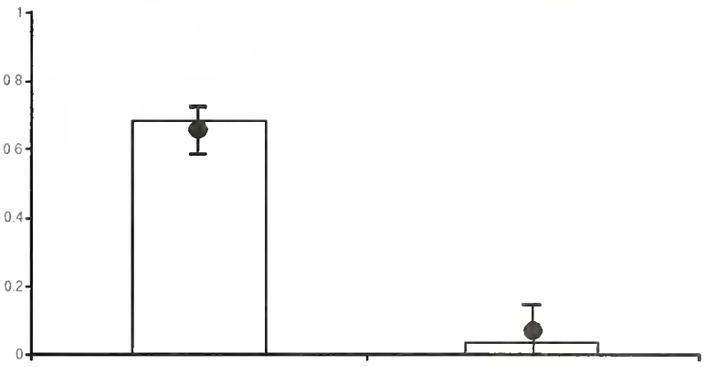

Figure 2. The relationship between dominant grass species and probability of occurrence of Bristled Grassbird *Chaetornis striata*. Bars show predicted values from the logistic regression model and black dots show observed probabilities (± 1 SE).

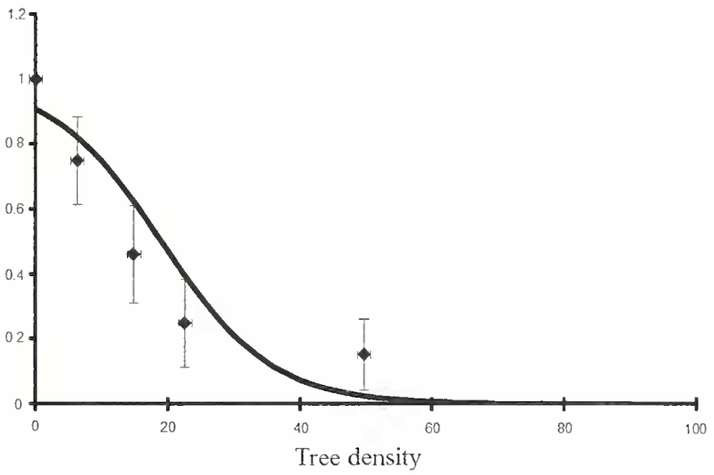

Figure 3. The relationship between tree density and probability of occurrence of Bristled Grassbirds. Bars show predicted values from the logistic regression model and black dots show observed probabilities (± 1 SE).

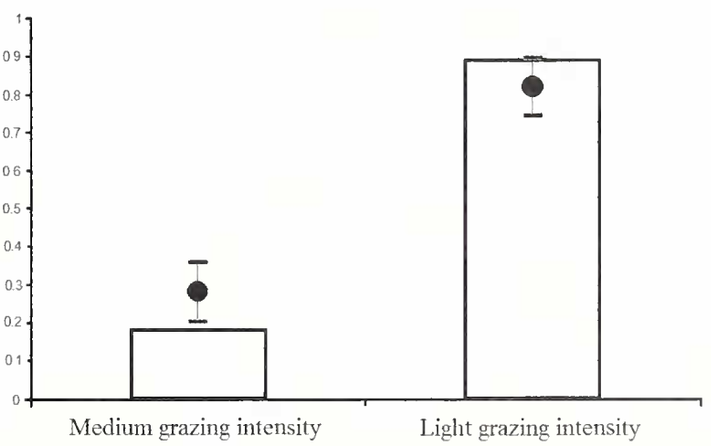

Figure 4. The relationship between grazing intensity and the probability of occurrence of Bristled Grassbirds. Bars show predicted values from the logistic regression model and black dots show observed probabilities (± 1 SE).

Threats

Overgrazing (affecting 90% of plots), fire (65%), forest roads or trails (27%) and invasive plant species (16%) were the main potential threats recorded in grassland plots used by Bristled Grassbirds. However, a multiple regression model failed to detect any relationship between the occurrence of any of these threats and Bristled Grassbird densities.

Other grassland birds

Plain Prinia was almost ubiquitous on the study plots (116 records), preventing presence-absence modelling. Grey-crowned Prinia (8 records) and Slender-billed Babbler (4 records) were recorded too infrequently to permit modelling. Both these species only occurred on study plots where Bristled Grassbirds were not found. Based on limited samples, Grey-crowned Prinia occurred on forest-edge plots with higher tree densities than plots occupied by Bristled Grassbirds, while the Slender-billed Babbler records were in plots with higher shrub densities.

DISCUSSION

Population estimation and habitat ecology

Bristled Grassbirds were detected using playback, which provoked birds into responding to defend their territories during the breeding season (Gregory *et al.* 2002), hence maximising the likelihood of detecting birds. Prior to using playback, only males displaying to attract mates were observed, so surveying without playback would have underestimated occurrence and population density.

There was no evidence that Bristled Grassbirds' requirements were conflicting with management for conservation-priority herbivores. The lightly grazed areas preferred by Bristled Grassbirds were principally grazed by wild herbivores including One-horned Rhinoceros *Rhinoceros unicornis*, Asian Wild Elephant *Elephas maximus*, Hog Deer *Axis porcinus*, Spotted Deer *A. axis*, Sambar Deer *Cervus unicolor* and Barking Deer *Montiacus muntjak*. In contrast, the observed levels of grazing by domestic livestock were detrimental to Bristled Grassbirds as the resulting heavily grazed grasslands were avoided. Overgrazing by domestic livestock occurs in other protected areas in Nepal. It is a major threat to the natural grassland in Suklaphanta Wildlife Reserve (Singh 2012b) and to grasslands of Koshi Tappu Wildlife Reserve (Singh 2013), although both are protected under the National Park and Wildlife Conservation Act 1973.

Grey-crowned Prinia and Slender-billed Babbler (both of which have the IUCN classification Vulnerable) occurred at the edges of grasslands in areas with higher tree and shrub densities (Singh 2012a). These findings illustrate that the habitat requirements of different grassland specialist species may not coincide, so habitat management plans must take these differences into account.

Grass diversity in preferred areas was relatively low, with *Saccharum spontaneum*, which grows up to 3 m in height after the monsoon flood retreats each year, being the dominant species. Older reports indicate that other grassland types, ranging from tall, wet (Baker 1922–1930) to shorter, drier formations (Hume & Oates 1889–1890, Baral 1997), may also be used where the species occurs outside Nepal.

Threats

Although the Chitwan NP authority does not burn grassland for management purposes, forest fires occur frequently, but irregularly, throughout the summer months. Sources of fire are likely to include those accidentally or deliberately set by villagers adjacent to the national park, nature guides or poachers hunting rhinoceros and tiger. Fires started during the breeding season may destroy nests and prevent further nesting, but this study detected no relationship between previous fire damage and Bristled Grassbird densities.

Invasive plants were only recorded on a small proportion of the study plots and, at these occurrence levels, no impact on Bristled Grassbird densities was apparent.

RECOMMENDATIONS

The impact of irregular and controlled burning on Bristled Grassbirds should be investigated to determine the long-term consequences of the current intervention regime on the grasslands, and whether these can be predicted. Furthermore, succession advancement should be controlled by means of controlled burning, tree felling and rotational management by grazing and grass cutting. Finally, a strategic Conservation Action Plan that incorporates grassland management should be initiated to accommodate the needs of Bristled Grassbirds alongside all the other grassland-dependent species inhabiting the Terai grasslands. The results of this research are based on data from the Rapti floodplain. It would be prudent to confirm our findings by studying the species in the Narayani River floodplain, Koshi Tappu Wildlife Reserve and Suklaphanta Wildlife Reserve.

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